Constraint Table List – Engineering of Common Residential Wood & Metal Doors

These tables summarize the primary engineering constraints used in residential construction in the United States (IRC, IECC, WDMA, AWS, SDI/ANSI A250, NFRC, and related standards). Values shown are the typical industry and code constraints for **standard residential applications** (one- and two-family dwellings and low-rise multifamily). Commercial or high-security doors have higher requirements.

1. Dimensional Constraints

Parameter	Wood Doors (Interior)	Wood Doors (Exterior)	Metal / Steel Doors (Residential)	Notes / Code Reference
Standard Height	80" (6'-8")	80" or 84"	80" or 84"	Most common; 96" available
Common Widths	24", 28", 30", 32", 36"	32", 36"	32", 36"	36" preferred for main entry
Minimum Clear Opening	32" (egress)	32"	32"	IRC / ADA
Rough Opening Allowance	+½" to +1" each side	+½" to +1"	+½" to +1"	Manufacturer specific
Maximum Practical Size	~48" × 120"	~48" × 96–108"	Varies by gauge & core	Beyond this requires special engineering

2. Thickness & Core Construction

Parameter	Wood	Metal / Steel	Constraint / Standard
Standard Thickness	1-3/8" (interior) 1-3/4" (exterior / fire)	1-3/4" (almost universal)	Fire-rated doors require 1-3/4" minimum
Core Types	Hollow core, Particleboard, Structural Composite Lumber (SCL), Solid wood, Stile & rail	Foam insulated, Honeycomb, Steel stiffened, Mineral core	WDMA I.S. 1-A / SDI
Face Material	Veneer, MDF, Hardboard, Solid wood	20–24 gauge steel (residential typical)	Lower gauge number = thicker steel
Typical Residential Gauge	—	22–24 ga faces common; 20 ga better security	SDI Levels 1–2

3. Fire Rating Constraints

Rating	Typical Use (Residential)	Wood Availability	Metal Availability	Notes
20-minute	Corridor / bedroom separation	Common	Common	Most frequent residential fire door
45-minute	Higher separation	Available	Available	
60 / 90-minute	Rare in pure residential	Limited	Available	Usually commercial
Positive Pressure	Required in many modern codes	Category A or B labeling	Same	NFPA 80 / UL 10C

4. Thermal Performance (IECC / NFRC)

Climate Zone	Max Fenestration U-Factor (IECC 2021 typical)	Typical Wood Exterior Door	Typical Insulated Steel Door	Notes
1–2	0.40–0.50	0.30–0.40	0.20–0.30	Opaque doors often better than glazed
3–4	0.30	0.25–0.35	0.17–0.28	
5–8	0.30 or lower	0.22–0.32	0.15–0.25	High-performance foam cores needed
Air Leakage	≤ 0.3–0.5 cfm/ft^2	Same	Same	NFRC / ASTM E283

5. Structural & Hardware Constraints

Parameter	Wood	Metal / Steel	Constraint
Hinge Quantity (6'-8" door)	3 hinges minimum	3 hinges minimum	Heavier doors or 7'+ height often need 4
Hinge Size	3½" or 4"	4" or 4½"	Matches door thickness & weight
Warp / Flatness Tolerance	≤ ¼" (6.4 mm) in any direction (typical WDMA/AWS)	Much tighter (steel is inherently stable)	Critical for wood
Moisture Content (wood)	6–12% at time of manufacture / install	N/A	Excess moisture causes warp

Parameter	Wood	Metal / Steel	Constraint
Wind Load / Design Pressure	Per local code & manufacturer DP rating	Higher inherent strength	Coastal / high-wind zones require tested assemblies
Impact Resistance	Limited (unless special construction)	Better (especially 16–18 ga)	Missile impact in hurricane zones

6. Accessibility & Clearance Constraints (IRC / ADA)

Requirement	Constraint
Minimum clear width	32" (most residential egress doors)
Maximum threshold height	½" (beveled) or ¾" with specific conditions
Maneuvering clearance	Depends on approach direction (typically 18–60" on latch side)
Door opening force	≤ 5 lbf interior, higher allowed for exterior
Hardware height	34–48" above floor

7. Material-Specific Engineering Limits

Wood

- Warp, twist, cup limited by WDMA/AWS performance levels (Standard / Heavy / Extra Heavy Duty).
- Edge clearances after hanging typically 1/8" top & sides, ½–¾" bottom (or per manufacturer).
- Must be protected from extreme moisture swings after installation.

Metal / Steel

- Face sheet thickness governed by SDI Level (residential usually Level 1 or 2 → 20–22 ga).

- Must be galvanized or otherwise corrosion-protected for exterior use.
- Thermal break or insulated core required for energy performance in most climate zones.
- Frame gauge often 16–18 ga for residential prehung units.

Summary of Most Critical Constraints for Designers / Builders

1. **Thickness** – 1-3/4" almost mandatory for exterior and any fire-rated door.
2. **Fire rating** – Match the wall rating (commonly 20-min in residential).
3. **U-factor** – Must meet IECC climate-zone requirements if the door is part of the thermal envelope.
4. **Warp control** (wood) and **gauge** (steel) directly affect long-term performance and warranty.
5. **Hardware prep and hinge count** must match door weight and height.
6. **Air leakage** and proper weatherstripping are mandatory for exterior doors.

Would you like this expanded into a more detailed spreadsheet-style table (with exact code section references), focused only on exterior doors, or broken out by interior vs. exterior?